SYSTEM DESIGN

Design Considerations

Transferring liquid product into tank trucks and rail cars involves moving product from a fixed pipeline riser to various sizes of vehicles and containers that may be parked in a variety of angles and positions.

The logical solution is a loading arm assembly. The advantages include:

Transfer Efficiency - a loading arm is a section of pipeline capable of handling high flows and line pressures and can be moved both vertically and horizontally.

Ease of Operation – there is no cookie-cutter approach when it comes to loading arm assemblies. Each assembly is built to meet specific application requirements, such as flexibility, physical limitations, personal preference, operating experience, environmental requirements, and sizes and types of vehicles to be loaded or unloaded. And, a wide range of components can be added to a loading arm to enhance its capabilities, including valves, couplings, high level sensing devices, and vapor recovery attachments to name a few.

Improved Environment and Personnel Safety – loading arms, by design, are:

- **Self-Organizing** – self-contained, space-efficient.
- **Environmentally-Friendly** – they retract out of the way when not in use, thereby eliminating potential environmental hazards due to hose run-overs.
- **Health-Friendly** – since they are self-supported on a base with precision engineered swivels and torsion springs, loading arms do not require strenuous lifting or moving. They can be moved effortlessly in a variety of directions, even under fluid loads.

Anatomy of a Loading Arm Assembly

Swivel Joints – provide flexibility, movement and leak-free operation.

Pipe or Tubing – sometimes used in conjunction with hose; of suitable size and length to handle the flow and reach the compartment(s).

Counterbalance System – to support and distribute the weight of the assembly, making it easy to maneuver.

Best Efficiency

Loading arm assemblies are available in many configurations and sizes. Selection of the most suitable design for a specific application will ensure that you are getting an easy operating, low-cost, low maintenance, high-value solution. The best design also provides flexibility to permit efficient operation and still fit within all physical limitations of the installation. The following characteristics are designed into every OPW Engineered Systems Loading Arm assembly:

Ease of Operation

Can be easily handled by one operator without heavy pushing, pulling or lifting.

- Can easily be extended to the furthest fill connection.
- Have a vertical movement with a built-in mechanical force that will handle most of the load when raising or lowering the loader.
- Can be equipped with a mechanical lock that will hold it in the down position.
- Have a loading valve that can be opened and then held open easily.

Adequate Horizontal and Vertical Range

- The ideal loader has sufficient range to reach all compartments of the longest vehicle at the rack without re-spotting the vehicle.
- It will have sufficient vertical movement and drop tube length to give sub-surface loading on the lowest vehicles.
- Should have at least a 5° downward slope toward the outboard end when filling the highest vehicle.
- Tight connections to vehicles may require additional swivel planes of rotation to accommodate easy alignment of couplings and good connections.

Rack Design

At the design stage, consideration must be given to riser pipe spacing, roof height, headroom, operation of gangways or access equipment, location of support columns, obstructions that could interfere with the loading operation, and storage.

Adequate Capacity Without Excessive Pressure Drop / Line Size

SYSTEM DESIGN

- Typically, the loading arm assembly is the same size as the plant piping on which it is installed.
- Must be capable of handling the design capacity without excessive pressure drop.
- Pump size and loader pipe diameter must be given consideration in order to ensure economic advantages.
- As a general rule, it is recommended that the line velocity not exceed15-20 ft./sec. (4.6 to 6.1 m./sec.).

LINE SIZE	MAXIMUM FLOW RATE BY LINE VELOCITY	
	15 Ft. Per Sec.	20 Ft. Per Sec.
2″	150 GPM	200 GPM
3″	350 GPM	450 GPM
4″	600 GPM	800 GPM
6″	1350 GPM	1800 GPM

Ease of Maintenance

- Consideration should be given to the operation and maintenance facilities at the point of use.
- The addition of excessive mechanical features mean additional service requirements.

Product Being Handled / Material Construction

- The loader must be designed and constructed to handle the required products.
- Metals, seals and gaskets must be chemically compatible with the products being handled, as well as their transfer temperatures and prevailing climatic conditions.

Top or Bottom Loading

Bottom loading offers:

- Personnel safety advantages – personnel remain on the ground.
- Reduction in static build-up during loading.
- Reduction in vapors.
- Improved loading times.
- Cost savings relative to loading rack construction.

Standard plant practice, personnel preference, safety and environmental requirements, the nature of the product, and how vehicles are equipped will determine whether top or bottom loading is used.

Balancing Method

Torsion Spring

- Is self-contained and space efficient.
- Can be adjusted to make the vertical lifting action of the arm respond in virtually any manner desired.
- Lowering the arm winds the spring tighter so that when the arm is released after loading, the spring unwinds and effortlessly lifts the arm upward.

Counterweights

- Can be used to balance arm, but are rarely used today.
- Requires larger space behind arm to accommodate both horizontal swing and vertical movement.

Pneumatic and Hydraulic Cylinders

- Can be used on specialized applications to balance and operate arms.

Moment Load

Moment load is the overturning force exerted at a particular point and is caused by a weight whose center of gravity is located at some distance from that point. The importance of this is that adding or reducing weight on an arm will affect its balance and operation.
The addition of components, such as insulation, tracing, valves and even retained product must be given consideration in the design stage since they will affect the weight and balance of the arm and may require changing the spring balance unit and adding swivels to the arm design.